Function Evolution and Landscape Planning Strategy of Inland Rivers in Beilun Port City of Ningbo

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Abstract In the history, the main roles of inland rivers in Beilun Port City of Ningbo were desalination, blocking tides, shipping, and flood control. Nowadays, with the continuous spread and deepening of urbanization, the ecological environment of river courses has been destroyed. In the past, remediation measures based on engineering and technology played a certain role, but can not "cure the root cause". It should respect the historical evolution process of river courses, and highlight the ecological service function and leisure tourism value of river courses from the coordination perspective of urban and rural ecological environment, economic industries, society and culture in the planning ideas of ecology, production, and life integration. Four aspects of the measures are as below: protecting and repairing the ecological matrix of river courses; building green space system and maintaining flood control functions through the water network; protecting cultural heritage along the rivers; developing waterfront leisure tourism scenic area.

Keywords Beilun Port City, Inland river, Function evolution, Landscape planning
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Beilun Port City is located in the eastern border of Ningbo City, Zhejiang Province. In ancient times, it was known as "a district of salt rejection and a place of sea immersion". Today, it is an important modern coastal port city in China. The river network within the territory is dense, and it has undergone changes in the past. From the desalination and flood discharge channel in the seawall, it has become a canal that connects with maritime transportation. Nowadays, like other inland rivers in China[1-2], their ecological issues have become a hot topic of concern due to the impact of urbanization. Especially for the inland rivers within Beilun Port City, which are affected by both the city and the port's economy, society, and environment, how to restore the ecological environment of river courses, respect the historical evolution process, and play the role of ecological services is the most critical issue in river management.

There are many achievements in studying the evolution of river courses, most of which are studies on the changes of river courses from a historical and geographical perspective[3-5]. However, the research achievements on river course evolution from the perspective of river landscape planning are only sporadic[6-7]. In this paper, landscape planning strategies are proposed based on the function evolution of inland rivers in Beilun Port City by combining with urban and rural natural environment, social economy, and historical and cultural resources.

1 Overview of the inland river basin in Beilun Port City

The Beilun District, where the port city is located, is characterized by hill and plain interval terrain, including the southeast oriented Chuanshan Peninsula and the north-south oriented Lingfeng Mountains, forming a sea plain enclosed by the three sides. These plains and small mountain plains have become the current urban and rural construction areas, with a ratio of approximately 61 : 39 between mountainous and plain areas. The entire terrain slopes slightly from the mountainous areas to the coast. The valley water system in three sided mountains and the connected Yinzhou Plain water system cross the urban and rural areas within the territory, flowing into the sea from the northeast direction, and forming three major water systems: Xiaojia River, Yantai River, and Lu River (Fig.1, considering that the research scope does not involve Meishan Island and Daxie Island in the area, these two islands have been removed from the following figures). The Xiaojia River water system belongs to the southeast basin of Yinzhou, and is located on the south bank of the Yongjiang River. The total length of the river is 129.7 km, with a total basin area of 74.5 km^2. Its water comes from Dongqian Lake and Sanxipu Reservoir in Yinzhou District, and finally flows into the sea. Its main rivers include the Xiaojia River and the Sanyanqiao River, as well as 6 tributaries, with a width of 10 to 60 m. The main river channels of the Yantai River water system include the Yanhe River, the Dongtai River, and the Xitai River, with a total length of 277.6 km and a drainage area of 151.9 km^2. The widest river channel is 100 m, while the narrowest river channel is 12 m. The Lu River water system is located on the east side of the Yantai River water system, with main rivers including the Lu River and the Chaiqiao River. The drainage area of this water system is 91.57 km^2, with a total length of 145.5 km. The widest river channel is 70 m, while the narrowest river channel is 12 m. The basic situation of each major river channel is shown in Table 1.

2 Function evolution process of inland river basin in Beilun District

2.1 Production and service functions of ancient river courses

2.1.1 Removing saltiness and blocking tides. Before the Tang and Song Dynasties, most places in Beilun belonged to "the area of bittern and the land of sea infiltration", namely the mudflat submerged by the sea tide, which could not be cultivated. In the Song and Ming Dynasties, in order to develop production, land was obtained by enclosing seawalls, and sluice was built on the river channel between the ponds to remove salt and moisture, block tide water, and drain flood water. For example, when Wang Anshi was appointed as the supervisor of Yin County, the Lu River was excavated, and Wanggong Pond and Chuanshan Gate were enclosed at Chaiqiao, which reclaimed a large area of land. From the Ming and Qing Dynasties to the 1980s and the 1990s, seawalls and sluices were built repeatedly, with a total of 11,000 hm^2 of land being reclaimed. Beilun became the hometown of rice and cotton (Fig.2-3). From this, a dense and crisscrossing river channel (Fig.1) has also been formed, and historical sluices were left, including the Lu River Chuanshan Sluice in the Song

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Dynasty, the Xiaojia River Donggang Sluice, Yanshan Sluice, and Yicheng Sluice, as well as Shiqiu Sluice of the Yingluo River (upstream of the Yanhe River), Changshan Sluice (commonly known as Daqi), and Zaoxin Sluice (Yongfeng Sluice) in the Ming and Qing Dynasties. It can be seen from this that the Beilun River was closely related to agricultural production and served as the infrastructure for regulating the natural ecological environment in history.

2.1.2 Canal shipping. According to the record of the *Beilun District Chronicle*, there were two inland waterway shipping areas in Beilun as early as the Yuan and Ming Dynasties. In the middle of the Ming Dynasty, shipping was an important mode of transportation. In the early Republic of China, shipping was also quite prosperous (Fig.2). From the establishment of New China until the 1970s, inland waterway shipping became the main mode of transportation, which was of great significance to the economic development of Beilun. The shipping function of the Xiaojia River, the Yanhe River, the Lu River, and the Tundai River (now the Qingshui River) reached its peak in the 1930s (Table 1). Chaiqiao Town, through which the Lu River passes, was prosperous as early as the Ming and Qing Dynasties due to water transportation of goods. With the rise of road transportation after the 1970s, rivers gradually lost their shipping function.

2.2 Modern and contemporary flood control function of river courses

With the gradual expansion of agricultural production scale after the liberation, villages and towns gradually spread from mountainous areas and piedmont to plains facing the sea. The original farmland and lakes that had flood control functions continued to shrink. At the same time, the elevation of the construction area was raised, and permeable ground was decreased. Rainwater flood volume increases in the plum rain season from March to July and rainstorm season from August to September every year. According to the statistics of the *Beilun District Chronicle*, there were 28 typhoons with serious impact from 1971 to 2006, with an average of 0.8 typhoon per year, including 12 rainstorms (Table 2)[8]. The water from mountainous and plain areas is discharged into these inland rivers. In addition, factors such as tidal backflow cause urban waterlogging, making flood discharge become an important function of inland rivers (Table 1).

2.3 Ecological environment problems of rivers under the background of eco–nomic development and urbanization in Beilun

In 1978, Beilun Port was established, and multiple national level parks were established subsequently, leading to rapid economic development in Beilun. Industry is dominant in the district, accounting for 56.9% of the output value in 2016. Among them, port industries such as petrochemicals, steel, energy, and paper have a significant impact on the environment and rivers, including Lianhe Industrial Zone, Qingzhi Industrial Zone, Jiangnan Export Processing and Trade Zone, Beilun Power Plant, and Taisu Industrial Zone (Fig.4). Although agriculture accounts for a small proportion, there are problems with extensive development and uncontrolled management, as well as limited green and organic planting areas. This industrial structure and production method directly or indirectly affect the ecological environment of rivers. In addition, there are problems in the old urban areas, such as a lack of sewage facilities, dense buildings and a lack of green space, and difficult environmental management, which have a significant impact on the ecological system of the river basin, such as the old town areas of Xinqi Street, Daxie Street, Chaiqiao Street, Xiapu Street, and Sanjiangkou. Meanwhile, some old residential areas lack ecological and environmental facilities, and residential, industrial, production, and service land mix, and it lacks environmental management, which are also the main reasons for river pollution in the watershed (Fig.4)[9]. According to the *Beilun District*

Table 1 Basic situation of main river channels in Beilun District

River system	River name	Starting point	Finishing point	Length km	Width m	Drainage function	Ancient shipping
Xiaojia River water system	Xiaojia River	Taishi Bay	Jiashui Gate	18.000	30–60	√	√
	Sanyanqiao River	Yinbei Border	Wangjiayang Gate	7.380	10–29	√	
	Tongtu Road Branch River	Taishi Bay	Wangjiaxi	11.550	16–30	√	
	Youcheqiao Branch River	Youcheqiao	Zhonghujia	0.480	10–29	√	
	Fengjiadou Branch River	Gujia	Laolijia	0.327	30	√	
	Weidou Xiaojia River	Biaodun	Pushan	2.930	30–40	√	
	Lile Branch River	Xiafangqian	Beilile	0.710	30	√	
	Donghujia Branch River	Donghujia	Yantou	0.640	30	√	
Yantai River water system	Yanshan River	Yingluo	Suanshanqi	14.500	21–40	√	
	Fengyang River	Yanhe	Yantanghe	5.170	12	√	
	Yanhe River	Yingluo	Xiasanshan Gate	14.100	35–100	√	√
	Xitai River	Tazhi Dayu Mountain	Xiasanshan Gate	8.740	30	√	√
	Dongtai River	Miaohejiang	Xiasanshan Gate	7.100	25–32	√	√
	Shawan River	Miaohejiang	Dongtaihe	5.000	25	√	
	Maojiao River	Miaohejiang	Maojiao Gate	6.120	15	√	
	Science and Technology Park River	Yanshan River	Fengyang River	3.560	12		
	Autocity River	Yanshan River	Fengyang River	3.560	15		
	Xiehe Flood Discharge River	Lu River	Xiehe Gate	6.100	15	√	
	Yantang River	Yanshan River	Yanhe River	4.730	12	√	
Lu River water system	Chaiqiao River	Ganxi Village	Lu River	5.500	15–41	√	√
	Lu River	Ruiyan Reservoir	Chuanshan Gate	10.120	20–70	√	√
	Zhongxin River	Fengyang River	Xiehe Flood Discharge River	11.250	10–15		
	Fuchun River	Yingluo	Lu River	3.100	12	√	
	Tongtu Road River	Yanshan River	Fengyang River	2.510	20		
	Miaojiang River	Yingluo	Lu River	20.000	15	√	
	Qingshui River	Yingluo River Estuary	Hengshan	16.300	30–60		√

Chronicle, pollution was severe year by year in the 1990s, dropping from Class II water bodies to Class III water bodies, especially in the Xiaojia River and the Yantai River where ammonia nitrogen and total phosphorus exceeded the standard. In March of 2016, the monitoring results of the "Three Rivers" showed that 23 rivers had poor water quality classified as "Inferior Class V"; 3 rivers had poor water quality classified as "Class V", and 5 rivers had poor water quality classified as "Class IV". According to the monitoring data of cross township river sections, the water quality of the Yanhe River, the Maojiao River, Yandong Bridge section of the Taihe River, and Zhonghe Gangwu Xincun Bridge section is classified as "Inferior Class V", while the rest of the river sections are basically classified as Class V and III, with a few classified as Class II. The water quality monitoring results of 10 district level "river chief system" rivers are also not optimistic[10]. In recent years, Beilun District has been committed to the "five water co governance", adopting engineering technology restoration and coastal greening as the main measures. At the same time, biological treatment, full vegetation slope and bank protection, and ecological water replenishment measures have been adopted, and the water environment has been improved, but it still cannot be eradicated. According to the Water Environment Quality Briefing of Beilun District in May of 2023, the proportion of rivers below Class III is relatively high (Table 3)[11], and the water quality of rivers located in various streets is even more pessimistic (Table 4)[11].

3 Landscape planning strategies for inland rivers in Beilun Port City

The ecological construction of rivers in Beilun District still has a long way to go. The government should transform ecological construction measures, and not be limited to ecological engineering treatment of river systems and increasing green spaces on both sides. It should respect the historical evolution process of rivers, and highlight the ecological service function and leisure tourism value of rivers from a coordinated perspective of urban and rural ecological environment, economic industry, and social culture in an idea of ecology, production, and life integrated planning.

3.1 Protecting and restoring the ecological substrate of river channels

The ecological environment of rivers is closely related to their dependent ecological matrix. The ecological matrix environment is good, and the water environment is also relatively good. Specifically, it can be achieved through the following aspects: one is to protect the ecologically sensitive upstream areas, and the other is to restore the damaged midstream and downstream ecosystems. The ecological environment of the river channels in Beilun Port City shows a clear gradient pattern, with the ecological environment deteriorating in the directions of mountains, rural areas, cities, and ports. The upstream mountains and rural areas of the water source belong to ecologically sensitive areas, and protection methods are adopted for them. Downstream cities and ports belong to ecologically damaged areas, and restoration methods should be adopted for them.

3.1.1 Protecting ecologically sensitive areas. Ecologically sensitive areas closely related to river channels include natural mountains with water conservation functions and river networks farmland in front of mountain. The mountainous areas within Beilun cover a large area, serving as both water conservation and ecological barriers, forming an ecological matrix, such as Qijia Mountain, Jinji Mountain, Ruiyan Mountain, Taibai Mountain, and Wanqiu Mountain, which play a crucial role in maintaining the landscape pattern of the river. The protection measures are: strictly protecting the environment such as mountains, plants, terrain and landforms; opening up suburban parks and carrying out leisure activities such as cultural tourism and natural sightseeing appropriately (Fig.5).

In addition, river network area in front of

Table 2 Typhoon records with severe impact in Beilun from 1971 to 2006[8]

Year	Rainfall//mm	Year	Rainfall//mm
1971	130.9	1989	101.1
1972	92.3	1990	89.0
1974	133.7	1992	125.3
1976	193.2	1992	93.7
1977	228.9	1994	72.0
1977	76.0	1997	80.4
1979	20.0	1998	19.8
1979	54.0	1999	100.8
1981	75.4	2000	44.2
1983	17.4	2000	153.4
1985	71.3	2001	123.1
1986	15.4	2002	45.7
1987	140.2	2005	370.9
1988	22.4	2005	253.3

Table 3 Water quality and changes in sections above district control from January to May of 2023[11]

No.	River	Section	January–May of 2022	January–May of 2023
1	Yong River	Zhangjian Sluice	III	IV
2	Xiaojia River	Xiashao	III	III
3		Xiaogang	III	III
4	Yan River	Yejia	II	II
5		Yanhe Bridge	III	III
6	Lu River	Chaiqiao Water Plant	II	II
7		Shanmen	III	IV
8	Sanshan River	Qinglongqi Bridge	III	II
9	Yanshan River	Wujinqi Bridge	III	III
10	Miaohe River	Xiapu Industrial Park Bridge	III	III
11	Baifeng River	Baifeng Town Government Bridge	III	III

Table 4 Water quality situation of each street from January to May

No.	River	Section	January–May of 2022	January–May of 2023
1	Jiangnan River	Jiangnan River (Xiaogang out)	V	IV
2	Xiaojia River	Jingtouan Bridge (Xiaogang out and Qijia Mountain in)	III	III
3		Xiaogang Bridge (Qijia Mountain out)	III	V
4	Yan River	Guansheng Bridge (Daqi out and Xinqi in)	IV	IV
5		Yanhe Bridge (Xinqi out)	IV	III
6	Zhong River	Experimental Kindergarten Bridge (Daqi out and Xinqi in)	Inferior V	Inferior V
7		Gangwu Xincun Bridge (Xinqi out)	Inferior V	Inferior V
8	Tai River	Shipu Haosheng Bridge (Daqi out and Xinqi in)	IV	V
9		Yandong Bridge (Xinqi out)	V	V
10	Maojiao River	Ninggang Office Building (Xiapu out)	IV	IV
11	Lu River	Shanmen Bridge (Chai Bridge out)	III	III
12	Baifeng River	Baifeng Town Government Bridge (Baifeng out)	III	III
13	Sanshan River	Qinglongqi Bridge (Chunxiao out)	III	II
14	Meishan River	Xingang Road Bridge (Meishan out)	III	III
15	Ximen River	Baiyangxian Bridge (Guoju out)	IV	IV

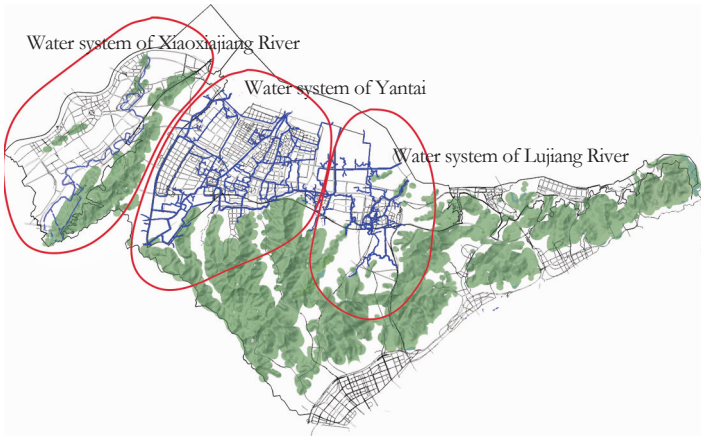

Fig.1 Overview of the river channels in Beilun Port City

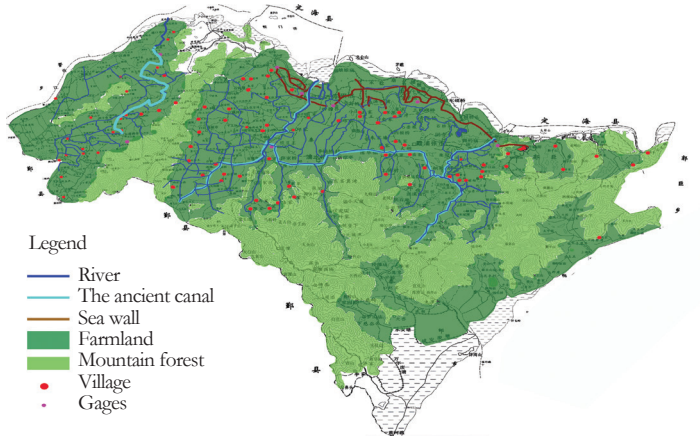

Fig.2 River basin in Beilun District in 1932

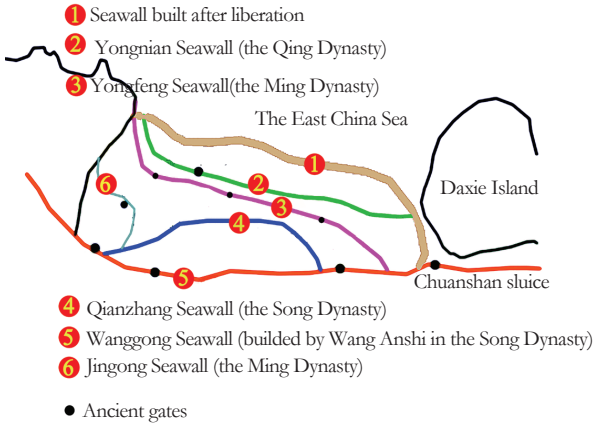

Fig.3 Construction of Beilun seawalls throughout history

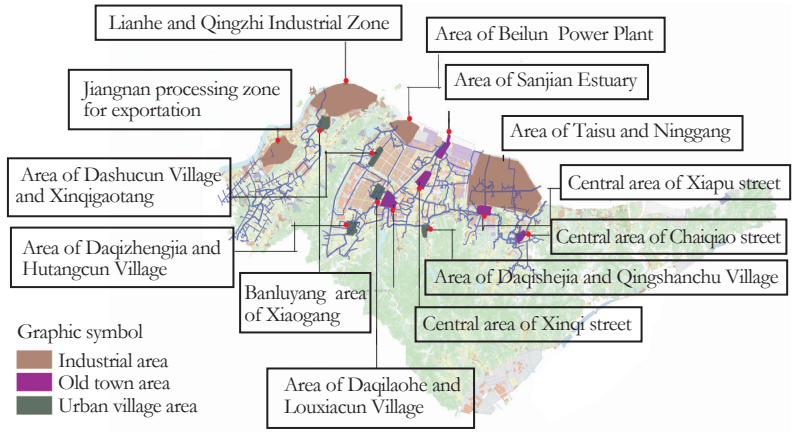

Fig.4 Main ecological restoration areas

the mountain is a rural landscape area with a low degree of urbanization. The river channels, villages, and farmland maintain a good landscape pattern, which is also a key focus of ecological protection. The scope includes: ① the front section of the Lu River in the Lu River water system, a village in front of the mountain surrounded by the Donghu Mountain, the Yunwu Mountain, Kunting Daling, and Nianmu Tiangang. ② Villages such as Hong'ao, Shangshi, and Hongxi, where the southern tributary of the Miaojiang River in the Lu River water system is located. ③ The front section of the Yantai River water system, including villages in front of the Hengshan Mountain and the Hejia Mountains. ④ The front section of the Yanshan River, the Yanhe River, and the Qingshui River in Yantai River water system, including the villages in front of mountain surrounded by the Xiangshan Mountain, the Paotai Mountain, and the Guogai Mountain. ⑤ The villages in front of mountain on both sides of the Shuangfeng Mountain. Protection measures include: protecting basic agricultural land and developing ecological organic agriculture; protecting the natural habitat of rivers and reducing artificial interference; preserving villages with traditional characteristics, such as Chaiqiao Sihe Ancient Village, Daqi Jiaxi Village, and Yingluo Village, and renovating general villages; properly carrying out tourism activities such as river boating, hiking, photography, agricultural sightseeing, and village cultural experiences, so that citizens can enjoy the benefits brought by river protection and enhance their ecological awareness; developing wetlands in areas with dense river networks and low-lying areas to improve urban flood control capacity, biodiversity, and ecological environment quality (Fig.5).

3.1.2 Repairing damaged ecosystems. During the process of rivers flowing through cities, they are increasingly disturbed and damaged. Firstly, there is a decrease in green spaces along the rivers. Secondly, the degree of pollution increases, especially in the rivers that flow through industrial areas, urban villages, and old urban areas. The specific distribution is shown in Fig.4. In addition to engineering technology restoration and pollution interception, it also needs to adopt planning and remediation methods, including the use of ecological green belts in industrial areas and riverside areas to isolate the impact of exhaust gas and waste on the river channel; in urban villages and old urban areas, it is advisable to demolish disorderly buildings by the water, build ecological green spaces, and open waterfront leisure parks. For some villages and towns with historical and cultural value, methods such as protection, construction, and drainage should be adopted to sort out the river blocks, revive traditional culture, restore urban vitality, and enhance the utilization value of rivers, such as Chaiqiao Old Street. The port area located in the Sanjiangkou plot in Fig.4 is characterized by mixed transportation, dense buildings, complex pedestrian flow, high levels of wastewater, exhaust gas, dust, and solid waste, as well as pollution from various mechanical equipment. Moreover, it is located at the outlet of the river channel, and the water quality at the outlet is poor after passing through urban and rural areas. Therefore, the port area is a key location for water ecological restoration, and it is advisable to layout large areas of ecological forests and wetlands (Fig.5).

3.2 Constructing green space systems and maintaining flood control functions through water networks

The river system in the area is densely distributed and has good connectivity, forming a network structure. By planning the water and green network, the connectivity between green spaces is ensured, and the green space of the park is integrated together, which can greatly improve the ecological environment, build a good landscape pattern, and benefit biodiversity. At the same time, it should strictly protect the existing river network system and connect the cut off rivers to maintain the flood control function of the river network. The green space system and wetland in river network are water absorbing sponges, which together constitute the urban flood control system. These green spaces in rivers can be divided into leisure green spaces and ecological green spaces according to their functions. Leisure green spaces are located in densely populated areas such as residential areas, urban centers, and industrial areas, while ecological green spaces are located in less populated suburbs and connected to rural areas and farmland. The specific plan is shown in Fig.6.

3.3 Protecting cultural heritage along the river

The river channel in Beilun District has a long history, and there are many cultural heritages distributed along the river, including ancient seawall relics, ancient Qiqiao, coastal defense projects, temples, villages, etc. These heritages can be protected in the form of green spaces and leisure scenic spots, forming a landscape with the river channel, protecting the heritage while also protecting the river environment (Fig.7).

3.4 Developing waterfront leisure tourism scenic spots

Practice has proven that tourism development can help improve the ecological protection awareness of citizens and enhance their environmental awareness under scientific and rational development. Specific measures include: developing waterfront mountains into suburban parks or scenic spots; water side forests and green spaces serving as leisure parks; using waterfront farmland as an ecological agricultural sightseeing park; traditional villages along the river being developed into rural tourism attractions such as farmhouses and homestays. The ancient towns that the river passes through have been developed into water town style of block in eastern Zhejiang, such as Chaiqiao Town. In addition, the navigation function of the canal could be restored, creating it as a heritage, scenic, and tourist corridor, opening up water tourism and leisure activities, and driving the development of tourism economy along the river banks. These rivers include the Xiaojia River, the Yan River, the Xitai River, the Dongtai River, the Chaiqiao River, the Lu River, the Qingshui River, and other ancient rivers (Fig.7).

4 Conclusions

The natural environment and economic and social characteristics of the rivers within Beilun Port City have certain peculiarities. These rivers served production in ancient times, such as blocking tides and removing saltwater, drainage and irrigation, navigation, and flood control. Nowadays, the ecological environment of rivers has been damaged due to the development of urbanization. Ecological remediation and restoration measures mainly based on engineering technology have played a certain role, but cannot "cure the root cause". To this end, a comprehensive planning strategy based on economy, society, and ecology is proposed, including protecting and restoring the ecological substrate of the river, constructing a network of urban green spaces, protecting cultural heritage along the river, and developing waterfront tourist attractions. These strategies

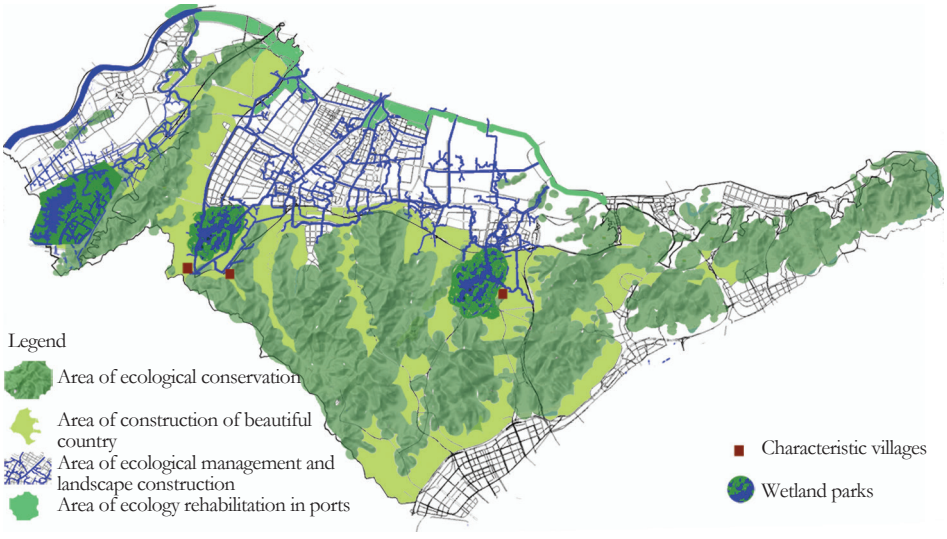

Fig.5 Protection area of ecologically sensitive area

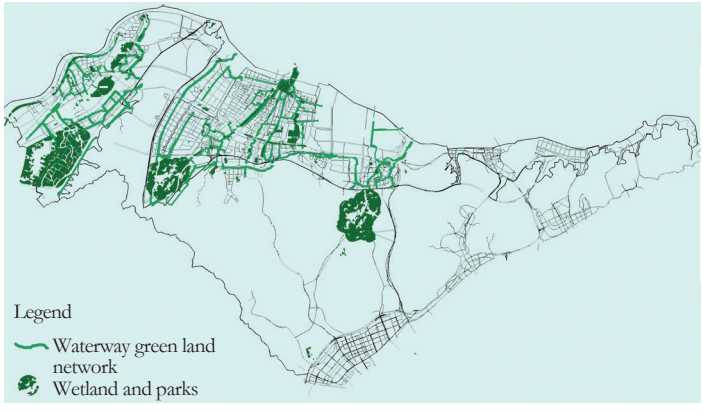

Fig.6 Green space network in rivers

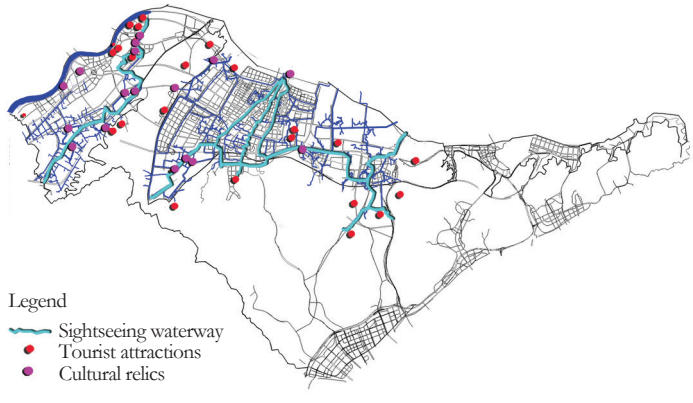

Fig.7 Historical and cultural heritage and tourist attractions of the river

(To be continued in P21)

Table 1 Standard definition and coverage of community commercial facilities in the livelihood service circle of Chunshu Street

Division	Group	Definition criteria for facility compliance			Facility coverage rate//%		
		5-minute walking distance	10-minute walking distance	15-minute walking distance	5-minute walking distance	10-minute walking distance	15-minute walking distance
Shopping service	Convenience store	—	▲	—	—	100	—
	Supermarket	—	—	▲	—	—	100
	Composite market	—	—	▲	—	—	100
	Shopping mall	—	—	▲	—	—	83.07
Catering service	Chinese restaurant	—	▲	—	—	100	—
	Fast-food restaurant	—	▲	—	—	99.8	—
	Foreign restaurant	—	—	▲	—	—	66.14
	Casual restaurant	—	—	▲	—	—	100
Life service	Beauty salon	—	—	▲	—	—	100
	Repair and care	—	—	▲	—	—	100
	Housekeeping	—	▲	—	—	26.39	—
	Couriers logistics	—	▲	—	—	63.54	—

comprehensively considering the influence of other factors. The city is a complex and dynamic system, and the construction of livelihood service circle in historic districts, as special areas, requires further in-depth study.

References

[1] The Xinhua News Agency. (2021). *Resolution of the Central Committee of the Communist Party of China on the significant achievements and historical experiences of the Party's centennial struggle*. Retrieved from http://www.mofcom.gov.cn.

[2] Hino, M., Liu, Y. G. & Tan, Y. W. (2010). Progress of Japanese urban geography after the 1950's and new directions. *Journal of Urban and Regional Planning*, (2), 118-131.

[3] Dai, J. (2016). Research and analysis of Japanese "life circle" concept. *China Real Estate*, (13), 36-37.

[4] Zhang, L., Lv, B. (2009). Main process and historical experience of Japan's capital city group planning. *Urban Development Research*, (12), 5-11.

[5] Feng, Z. Y., He, J. (2008). A study on the status-quo, position, developing models of urban community business in China. *Areal Research and Development*, (4), 47-51.

[6] Jing, C. (2007). *Study on pedestrian crossing characteristics* (Doctoral thesis). Retrieved from China National Knowledge Infrastructure.

[7] Liu, S. L. (2021). *Research on measurement and optimization of 15-minute community life circle in historic urban areas*: *Based on the case of Shuangtang Jiedao*, *Nanjing* (Master's thesis). Retrieved from China National Knowledge Infrastructure.

[8] Han, Z. L., Dong, M. R. & Liu, T. B. et al. (2020). Spatial accessibility evaluation and layout optimization of basic education facilities in community life circle: A case study of Shahekou in Dalian. *Scientia Geographica Sinica*, *40*(11), 1774-1783.

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(Continued from P16)

focus on systematicity and combine protection with development and utilization.

In short, it is an innovative approach to river protection and utilization by seeking solutions to ecological problems in river channels through historical dynamic evolution. Especially it has certain significance by extending the research perspective from the river itself to the related environment of the river basin, as well as the economic and social situation, and exploring the "symptomatic and fundamental" approaches to river regulation, providing reference for similar river regulation, protection, and development and utilization in China.

References

[1] Xue, Y. D., Yang, P. L. & Wang, C. Z. (2009). Ecological restoration of urban rivers. *China Rural Water and Hydropower,* (6), 70-72, 75.

[2] Gao, X. Q., Jiang, J. & Zhang, J. C. (2008). Research advance and developing tendency of ecological river. *Journal of Nanjing Forestry University*: *Natural Sciences Edition*, (1), 103-106.

[3] Fan, Z. L., Chen, Y. N. & Wang, Y. J. (2006). Study on the Tarim River and its watercourse evolution in Xinjiang: Recorded in the "Records of Rovers". *Arid Zone Research*, (1), 8-15.

[4] Pan, Q. M. (2001). Study on evolution of middle and lower reaches of Yangtze River in recent fifty years. *Journal of Yangtze River Scientific Research Institute*, (5), 18-22.

[5] Zhang, L. (2001). A study on changes of the river courses on ancient Loulan oasis and the reasons. *Journal of Chinese Historical Geography*, (1), 87-98, 127.

[6] Gong, Q. H., Yuan, S. X. & Chen, B. (2013). Evolution of the Pearl River course in urban area of Guangzhou and its influence on ecological environment. *Tropical Geography*, (4), 394-399.

[7] Zhong, G. Q., Chen, X. N. (2011). The planning research of Zhaoqing City water system and water landscape based on respecting nature and history: An example from Zhaoqing ancient river to the "Sapphire Necklace". *Chinese Landscape Architecture*, (2), 44-49.

[8] Ningbo Beilun District Local Chronicle Compilation Committee. (2013). *Ningbo Beilun District chronicle*. Hangzhou: Zhejiang People's Publishing House.

[9] Zhang, J. (2010). *Optimization and adjustment of urban land use in Beilun District, Ningbo based on urban land consolidation* (Master's thesis). Retrieved from China National Knowledge Infrastructure.

[10] Wushui Office of Beilun District. *Notice on the key tasks and project progress of "Five Waters Co-governance" in the first quarter of 2016 in Beilun District*. 2016-05-09[2023-09-05].http://www.bl.gov.cn/doc/zffw/zwdt/ztzl/wsgz/ydtb/661294.shtm

[11] Beilun Branch of Ningbo Ecological Environment Bureau. *Water environment quality briefing of Beilun District in May of 2023*. 2023-07-10 [2023-09-05].http://www.bl.gov.cn/art/2023/7/10/art_1229505554_59072697.html.